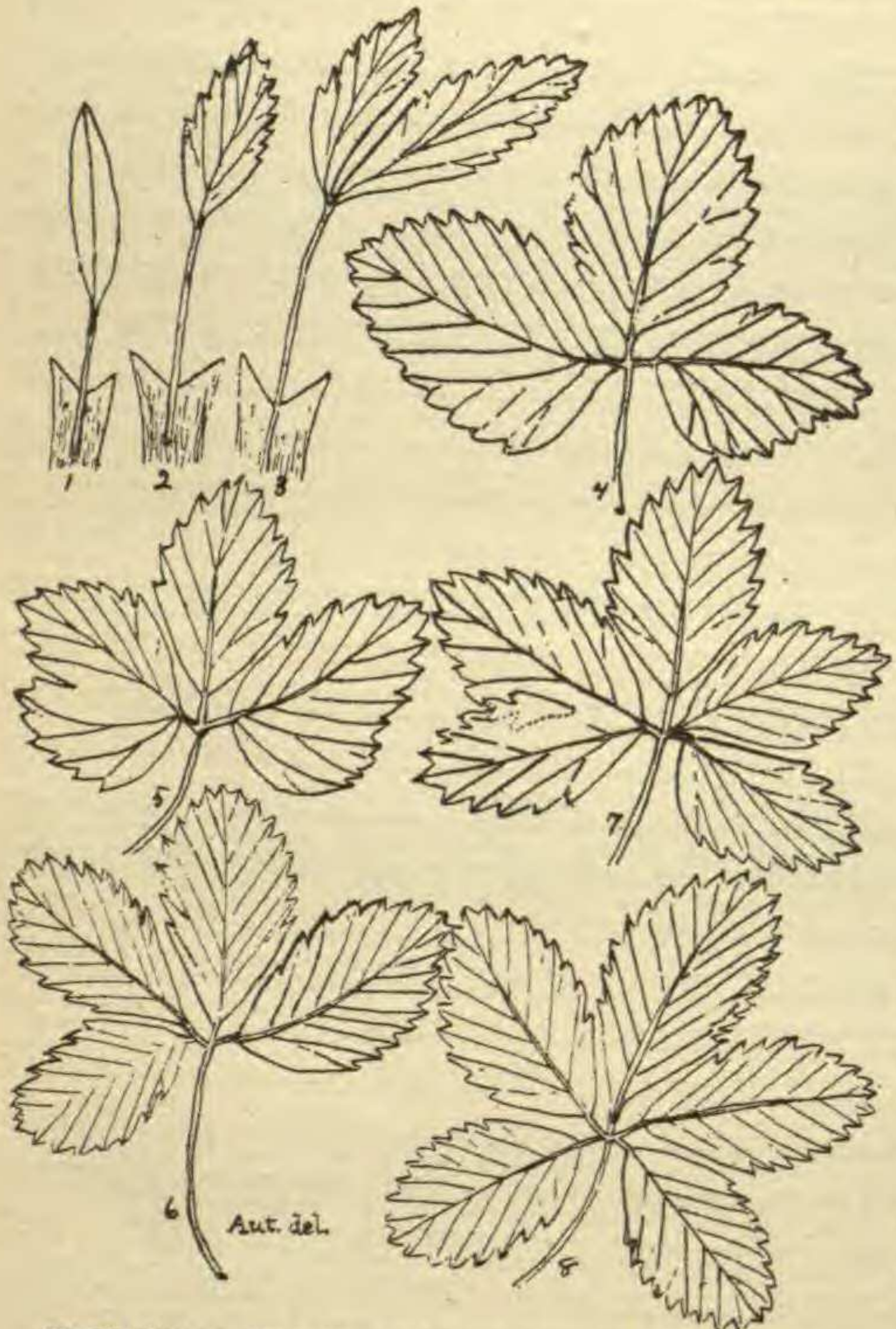
dentate margin has been added; larger, stronger veins have been formed and it is really become a strawberry leaf. Did not this single leaflet, in the sometime of the past, give off the two lateral leaflets, making it trifoliate? Does not fig. 3, give us an affirmative answer to our question? The transition forms (figs. 5, 6, 7,) have followed the same law in the development of these added leaves, which was suggested in the development of the trifoliate from the ancestral type. Descriptions of leaves ordinarily cover but the golden mean. Fig. 4 is the only one which is recognized as having a legitimate place among the leaves of the strawberry. The others are either "poor relations" which should remain in the background, or are too prosperous to remain in the humble household.



VARIATIONS OF THE LEAF OF THE STRAWBERRY.

But the leaves tell their own story so simply and so well that one needs but to give ear unto it in order to understand the progressive steps from the primitive leaf up to the possibilities of the future represented by fig. 8.—MRS. W. A. KELLERMAN, *Columbus, Ohio.*

On the development of the embryo-sac of Arisæma triphyllum. (WITH PLATE XVIII.)—The origin of the angiosperms and the true relationship between monocotyledons and dicotyledons are among the problems now demanding the attention of the botanists. From our present knowledge the monocotyledons may be regarded as the more primitive group from which the dicotyledons have been derived, or the dicotyledons may be looked upon as the primitive group, and the monocotyledons as degenerate forms derived from them. It seems highly probable, however, that one or the other is the correct view;

for in every representative of both groups, as far as is known to the writer, there is to be found the typical seven-celled embryo-sac, and it is hardly possible that such a structure could have arisen independently in both groups. If in any representative of either of these two groups of plants an embryo-sac should be found varying considerably, or even a little from the type, something toward a solution of the problem would at least be suggested. It is perhaps, among the lower forms that we are to seek such variations, if there are any. With this in view work was begun upon the development of the embryo-sac in Arisæma triphyllum. Although no variation from the common type in the structure of the mature embryo-sac was found, yet a few details in the process of development from the initial cell seem worth mentioning

The initial cell (mother cell) of the embryo-sac arises as a single hypodermal cell in the apex of the nucellus (figs. 1, 1*a*). This cell is well defined as soon as the first traces of the inner integument of the ovule is perceptible, or even sooner. All the cells now increase in size, and those of the epidermis divide by periclinal walls (fig. 2). The initial cell next divides by longitudinal walls into three or four cells two of which may be seen in longitudinal section (fig. 3). A transverse section at this stage of development shows four cells (*x*) which in all probability were derived from the initial cell. As far as is known to the writer, the longitudinal division of the initial cell of the embryo-sac has been observed and recorded only by Strasburger.[1] This author calls attention to a very unusual state of things in Rosa livida, where about four cells of similar size may be seen in longitudinal section.[2] He also states that he has seen two cells in longitudinal section, but he does not say in what plant or plants it was observed. One of these cells now enlarges considerably (fig. 5), and divides by a cross wall into two cells (fig. 6), the lower one being usually larger than the upper. The lower now absorbs the upper (fig. 7), and develops in the usual manner into the embryo-sac (fig. 11). (The intervening steps in the process are omitted here since they correspond to those of the type.) In the instance represented in fig. 6 the cross wall is only slightly swollen. In but one instance was the cross wall found to be greatly swollen (fig. 6*a*); in all other cases it was always of a more delicate structure, but not appreciably swollen. One instance was observed where there was no cross wall formed, the cell being slightly elongated with a large nucleus in each end and each nucleus accompanied by a vacuole as shown in fig. 6*b*. This, however, must be of very rare occurrence, for in the large number of successful preparations made at this point in the de-

[1] Die Angiospermen und die Gymnospermen, p. 14. 1879.

[2] l.c. p. 14, taf. IV, fig. 50.

velopment, either the nucleus was found in some stage of division, or a distinct wall was present.

During the development following the stage shown in fig. 7, the tissue of the nucellus surrounding the developing sac laterally is rapidly disorganized and absorbed, so that when the embryo-sac is mature, only the apical portion and a few plerome elements of the nucellus, together with the remains of a few disorganizing cells are to be seen. Embryo-sacs in ovules near the wall of the ovary are more elongated (fig. 8) than those of centrally placed ovules (fig. 9). This is due, of course, to pressure against the wall of the ovary mainly.

The position of the antipodal cells varies here as in almost all plants. In some cases all three appeared to lie side by side, others as shown in fig. 10.

It gives me great pleasure to express my sincere thanks to Dr. Douglas H. Campbell, of the Leland Stanford University, for numerous suggestions given me in this work.—DAVID M. MOTTIER, *Indiana University, Bloomington.*

EXPLANATION OF PLATE XVIII.—Figs. 1–3, longitudinal sections of the upper part of young ovules; 1 and 1*a*, × 206; 2, × 196; 3, × 236. Fig 4, transverse section of a nucellus at the point of growth shown in fig. 3; *x* are cells derived from the initial cell, × 310. Fig. 5, longitudinal section ofthe nucellus, the nucleus of the embryo-sac, mother cell in process of division, × 236. Fig. 6, similar to 5; the devision has been completed, × 206. Fig. 6*a*, similar to the shaded part of fig. 6 with the cross wall much swollen, × 236. Fig. 6*b*, similar to 6 with no cross wall. Fig. 7, the lower cell has become large through growth, × 236. Fig. 8, and 9, embryo-sacs with nucellus and portion of integument cells, × 136. Fig. 10, antipodal cells of embryo-sac, × 236. Fig. 11, embryo-sac of 8, × 236.

EDITORIAL.

OUR READERS will, perhaps, remember that two years ago (July, 1890) we mentioned the undertaking of the Commissioner of Education to report the condition of biological instruction in the colleges of this country. That report, long-looked-for-come-at-last, is somewhat disappointing. It is probable that the compiler, Dr. John P. Campbell, is not to be blamed for the tardiness of its publication. But the delay in the Government Printing Office has robbed it of much of its value, for the conditions have had time to change materially since the 1889–90 catalogues, on which it is based, were issued, and we know that, in some institutions, they have been changed much for the better. For the lack of digested and tabulated information, however,